BRITISH STANDARD

BS ISO 965-1: 1998

*Incorporating corrigendum July 2009*

# ISO general purpose metric screw threads — Tolerances —

## Part 1: Principles and basic data

ICS 21.040.10

# National foreword

This British Standard is the UK implementation of ISO 965-1:1998, incorporating corrigendum July 2009

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by ISO corrigendum July 2009 is indicated in the text by ▌AC1〉 〈AC1▐.

The UK participation in its preparation was entrusted by Technical Committee FME/9, Fasteners, to Subcommittee FME/9/3, Product standards for fasteners.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This British Standard, having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 April 1999



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# INTERNATIONAL STANDARD

# ISO 965-1

Third edition
1998-12-15

# ISO general purpose metric screw threads — Tolerances —

## Part 1:
## Principles and basic data

*Filetages métriques ISO pour usages généraux — Tolérances —*

*Partie 1: Principes et données fondamentales*

Reference number
ISO 965-1:1998(E)

## Contents



**Descriptors:** Screw threads, ISO metric threads, form specifications, dimensional tolerances, designation, generalities.

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 965-1 was prepared by Technical Committee ISO/TC 1, *Screw threads*, Subcommittee SC 2, *Tolerances.*

This third edition cancels and replaces the second edition (ISO 965-1:1980), which has been technically revised.

ISO 965 consists of the following parts, under the general title *ISO general purpose metric screw threads — Tolerances*

— *Part 1: Principles and basic data;*

— *Part 2: Limits of sizes for general purpose bolt and nut threads — Medium quality;*

— *Part 3: Deviations for constructional screw threads;*

— *Part 4: Limits of sizes for hot-dip galvanized external threads to mate with internal threads tapped with tolerance position H or G after galvanizing;*

— *Part 5: Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing.*

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## 1 Scope

[AC1]This part of ISO 965 specifies a tolerance system for ISO general purpose metric screw threads (M) conforming to ISO 261.[AC1]

The tolerance system refers to the basic profile in accordance with ISO 68-1.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 965. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 965 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

[AC1]ISO 68-1, *ISO general purpose screw threads — Basic profile — Part 1: Metric screw threads.*

ISO 261, *ISO general purpose metric screw threads — General plan.*

ISO 262, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts.*

ISO 724 , *ISO general purpose metric screw threads — Basic dimensions.*

*Text deleted* [AC1]

[AC1]ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality*

ISO 956-3*, ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads.*

ISO 1502, *ISO general purpose metric screw threads — Gauges and gauging.*

ISO 5408, *Screw threads — Vocabulary* [AC1]

## 3 Definitions and symbols

### 3.1 Definitions

For the purpose of this part of ISO 965 the definitions given in ISO 5408 apply.

[AC1] *Footnote deleted* [AC1]

### 3.2 Symbols

The following symbols are used:

| Symbol | Explanation |
|---|---|
| $D$ | basic major diameter of internal thread |
| $D_1$ | basic minor diameter of internal thread |
| $D_2$ | basic pitch diameter of internal thread |
| $d$ | basic major diameter of external thread |
| $d_1$ | basic minor diameter of external thread |
| $d_2$ | basic pitch diameter of external thread |
| $d_3$ | minor diameter of external thread |
| $P$ | pitch |
| $Ph$ | lead |
| $H$ | height of fundamental triangle |
| S | designation for thread engagement group “short” |
| N | designation for thread engagement group “normal” |
| L | designation for thread engagement group “long” |
| $T$ | tolerance |
| AC1 $T_{D1}$, $T_{D2}$ $T_d$, $T_{d2}$ AC1 | tolerances for $D_1$, $D_2$, $d$, $d_2$ |
| $ei$, $EI$ | lower deviations (see Figure 1) |
| $es$, $ES$ | upper deviations (see Figure 1) |
| $R$ | root radius of external thread |
| $C$ | root truncation of external thread |

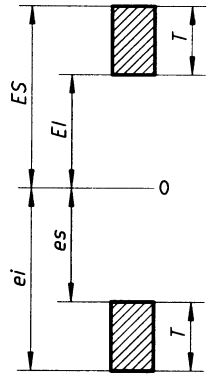



**Figure 1 — Position of tolerances with respect to zero line (basic size)**

## 4 Structure of the tolerance system

The system gives tolerances defined by tolerance grades and tolerance positions and a selection of grades and positions.

The system provides for:

a) a series of tolerance grades for each of the four screw thread diameters, as follows:

| | Tolerance grades |
|---|---|
| $D_1$ | 4, 5, 6, 7, 8 |
| $d$ | 4, 6, 8 |
| $D_2$ | 4, 5, 6, 7, 8 |
| $d_2$ | 3, 4, 5, 6, 7, 8, 9 |

Details of tolerance grades and combinations of tolerance grades for pitch and crest diameters according to tolerance quality and length of engagement group required, with order of preference, are shown in clause **12**.

b) Series of tolerance positions:

— G and H for internal threads;

— e, f, g and h for external threads.

The established tolerance positions comply with the need of current coating thickness and with the demands of easy assembly.

c) Selection of recommended combinations of grades and positions (tolerance classes) giving the commonly used tolerance qualities fine, medium and coarse for the three groups of length of thread engagement short, normal and long. Moreover a further selection of tolerance classes is given for commercial bolt and nut threads. Tolerance classes other than those shown in clause **12** are not recommended and shall only be used for special cases.

## 5 Designation

### 5.1 General

The complete designation for a screw thread comprises a designation for the thread system and size, a designation for the thread tolerance class followed by further individual items if necessary.

### 5.2 Designation of single-start screw threads

A screw thread complying with the requirements of the International Standards for ISO general purpose metric screw threads ⟦AC1⟩ in accordance with ⟨AC1⟧ ISO 68-1, ISO 261, ISO 262, ISO 724, ISO 965-2 and ISO965-3 shall be designated by the letter M followed by the value of the nominal diameter and of the pitch, expressed in millimetres and separated by the sign “×”.

EXAMPLE: M8 × 1,25

For coarse pitch threads listed in ISO 261, the pitch may be omitted.

EXAMPLE: M8

The tolerances class designation comprises a class designation for the pitch diameter tolerance followed by a class designation for the crest diameter tolerance.

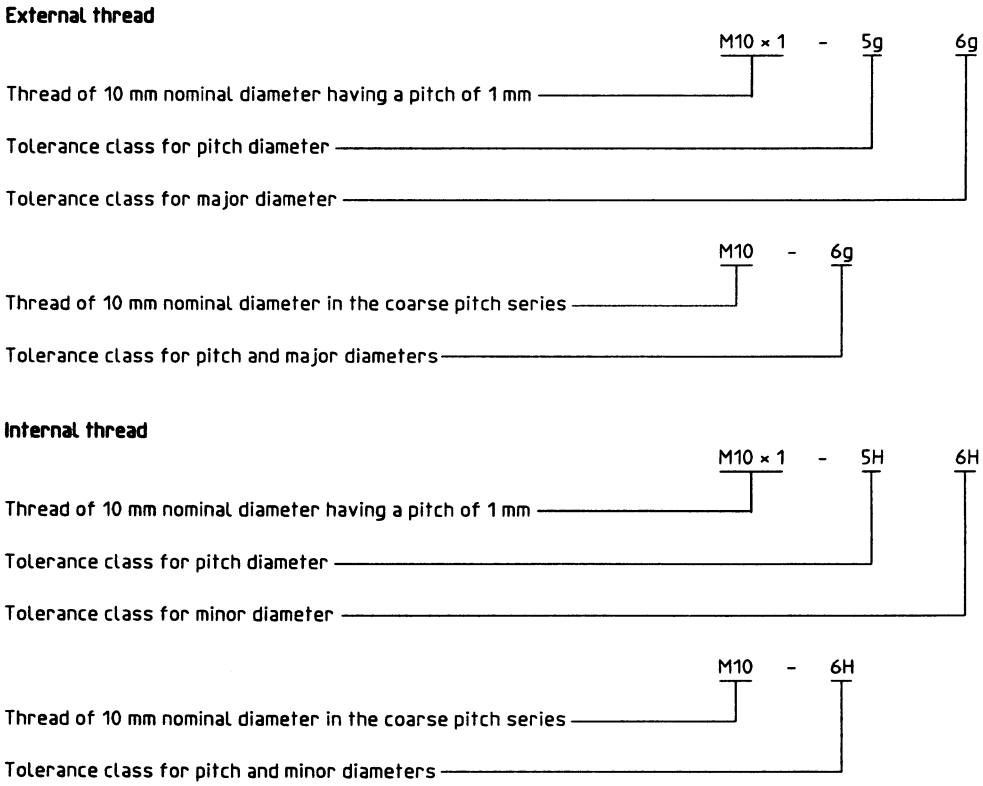
Each class designation consists of

— a figure indicating the tolerance grade;

— a letter indicating the tolerance position, capital for internal threads, small for external threads.

If the two class designations for the pitch diameter and crest diameter (major or minor diameter for internal and external threads respectively) are the same it is not necessary to repeat the symbols.

EXAMPLES:




A fit between threaded parts is indicated by the internal thread tolerance class followed by the external thread tolerance class separated by a stroke.

EXAMPLE:

M6 – 6H/6g

M20 × 2 – 6H/5g6g

The absence of tolerance class designation means that tolerance quality "medium" with the following tolerance classes are specified:

**Internal threads**

— 5H for threads up to and including M1,4;

— 6H for threads M1,6 and larger.

NOTE Except for threads with pitch $P = 0{,}2$ mm for which the tolerance grade 4 is defined only (see Table 3 and Table 5).

**External threads**

— 6h for threads up to and including M1,4;

— 6g for threads M1,6 and larger.

The designation for the group of length of thread engagement "short" S and "long" L should be added to the tolerance class designation separated by a dash.

EXAMPLE: M20 × 2 – 5H – S

M6 – 7H/7g6g – L

The absence of the designation for the group of length of thread engagement means the group "normal" N is specified.

### 5.3 Designation of multiple-start screw threads

Multiple-start metric screw threads shall be designated by the letter M followed by the value of the nominal diameter, the sign ×, the letters Ph and the value of the lead, the letter P and the value of the pitch (axial distance between two neighbouring flanks in the same direction) a dash, and the tolerance class. Nominal diameter, lead and pitch are expressed in millimetres.

EXAMPLE: M16 × Ph3P1,5 – 6H

For extra clarity the number of starts i.e. the value of $\frac{Ph}{P}$ may be added in verbal form and in paranthesis.

EXAMPLE: M16 × Ph3P1,5 (two starts) – 6H

**5.4 Designation of the left hand threads**

When left hand threads are specified the letters LH shall be added to the thread designation, separated by a dash.

EXAMPLES: M8 × 1 – LH
M6 × 0,75 – 5h6h – S – LH
M14 × Ph6P2 – 7H – L – LH
M14 × Ph6P2 (three starts) – 7H – L – LH

## 6 Tolerance grades

For each of the two elements, pitch diameter and crest diameter, a number of tolerance grades have been established. In each case, grade 6 shall be used for tolerance quality medium and normal length of thread engagement. The grades below 6 are intended for tolerance quality fine and/or short length of thread engagement. The grades above 6 are intended for tolerance quality coarse and/or long lengths of thread engagement. In some grades, certain tolerance values for small pitches are not shown because of insufficient thread overlap or the requirement that the pitch diameter tolerance shall not exceed the crest diameter tolerance.

## 7 Tolerance positions

The following tolerance positions are standardized:

— for internal threads: G with positive fundamental deviation
H with zero fundamental deviation
— for external threads: e, f and g with negative fundamental deviation
h with zero fundamental deviation

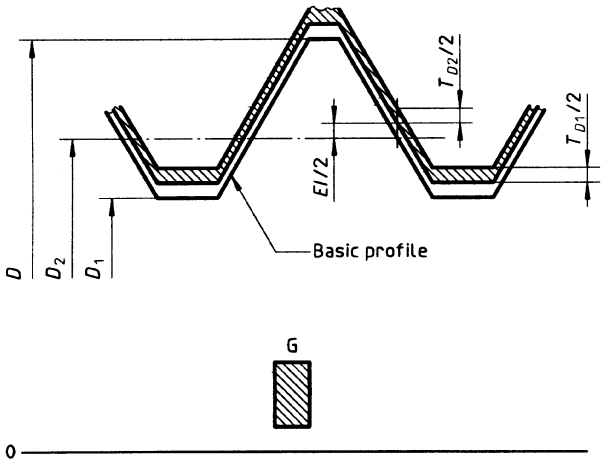



**Figure 2 — Internal threads with tolerance position G**

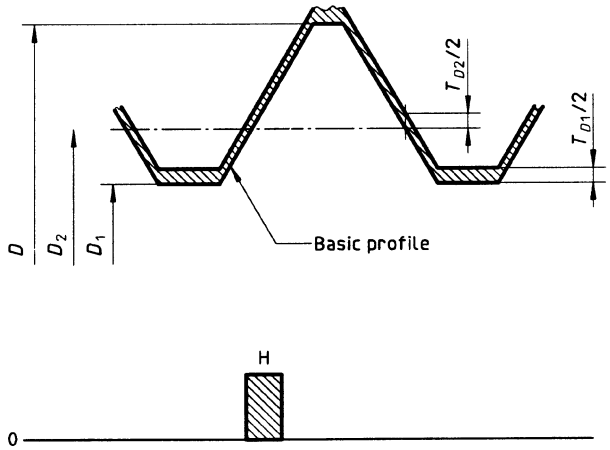
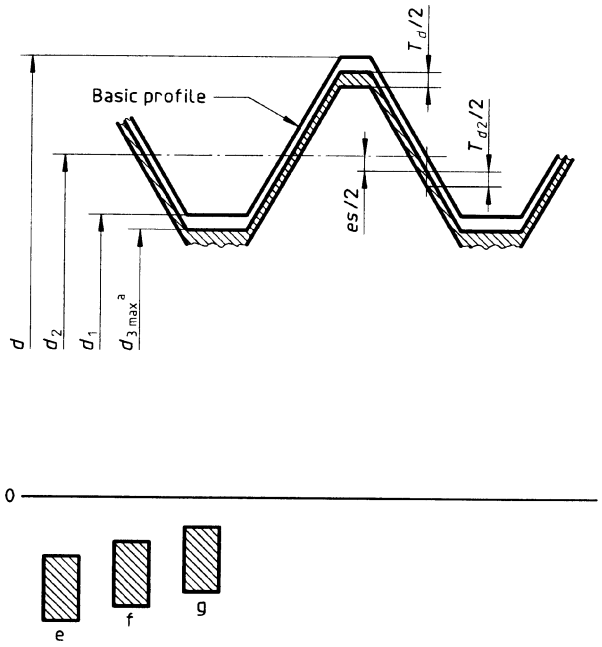
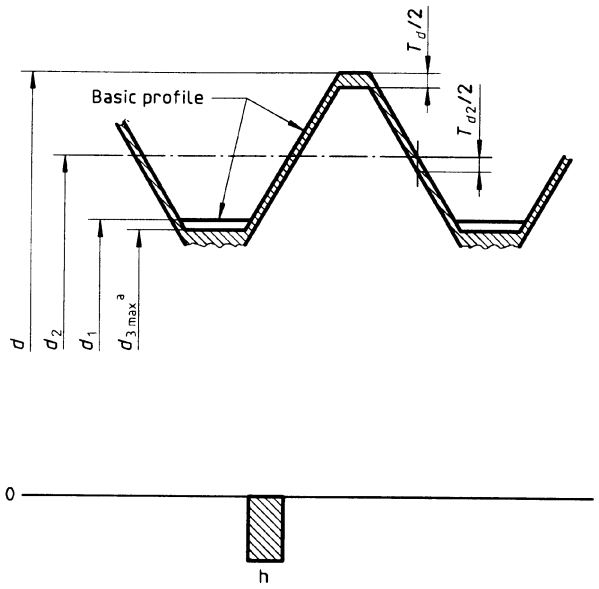



**Figure 3 — Internal threads with tolerance position H**




[a] Application only in connection with minimum material limits ($d_{2\,min}$), see clause **11**, Figure 6.

**Figure 4 — External threads with tolerance positions e, f and g**




[a] Application only in connection with minimum material limits ($d_{2\,min}$), see clause **11**, Figure 6.

**Figure 5 — External threads with tolerance position h**

**Table 1 — Fundamental deviations for internal threads and external threads**

| Pitch<br>*P* | Fundamental deviation | | | | | |
|---|---|---|---|---|---|---|
| | Internal thread<br>$D_2$, $D_1$ | | External thread<br>$d$, $d_2$ | | | |
| | G<br>*EI* | H<br>*EI* | e<br>*es* | f<br>*es* | g<br>*es* | h<br>*es* |
| mm | µm | µm | µm | µm | µm | µm |
| 0,2 | + 17 | 0 | — | — | – 17 | 0 |
| 0,25 | + 18 | 0 | — | — | – 18 | 0 |
| 0,3 | + 18 | 0 | — | — | – 18 | 0 |
| 0,35 | + 19 | 0 | — | – 34 | – 19 | 0 |
| 0,4 | + 19 | 0 | — | – 34 | – 19 | 0 |
| 0,45 | + 20 | 0 | — | – 35 | – 20 | 0 |
| 0,5 | + 20 | 0 | – 50 | – 36 | – 20 | 0 |
| 0,6 | + 21 | 0 | – 53 | – 36 | – 21 | 0 |
| 0,7 | + 22 | 0 | – 56 | – 38 | – 22 | 0 |
| 0,75 | + 22 | 0 | – 56 | – 38 | – 22 | 0 |
| 0,8 | + 24 | 0 | – 60 | – 38 | – 24 | 0 |
| 1 | + 26 | 0 | – 60 | – 40 | – 26 | 0 |
| 1,25 | + 28 | 0 | – 63 | – 42 | – 28 | 0 |
| 1,5 | + 32 | 0 | – 67 | – 45 | – 32 | 0 |
| 1,75 | + 34 | 0 | – 71 | – 48 | – 34 | 0 |
| 2 | + 38 | 0 | – 71 | – 52 | – 38 | 0 |
| 2,5 | + 42 | 0 | – 80 | – 58 | – 42 | 0 |
| 3 | + 48 | 0 | – 85 | – 63 | – 48 | 0 |
| 3,5 | + 53 | 0 | – 90 | – 70 | – 53 | 0 |
| 4 | + 60 | 0 | – 95 | – 75 | – 60 | 0 |
| 4,5 | + 63 | 0 | – 100 | – 80 | – 63 | 0 |
| 5 | + 71 | 0 | – 106 | – 85 | – 71 | 0 |
| 5,5 | + 75 | 0 | – 112 | – 90 | – 75 | 0 |
| 6 | + 80 | 0 | – 118 | – 95 | – 80 | 0 |
| 8 | + 100 | 0 | – 140 | – 118 | – 100 | 0 |

## 8 Lengths of thread engagement

The length of thread engagement is classified into one of three groups S, N or L, in accordance with Table 2.

**Table 2 — Lengths of thread engagement**

Dimensions in millimetres

| Basic major diameter *D, d* | | Pitch *P* | Lengths of thread engagement | | | |
|---|---|---|---|---|---|---|
| | | | S | N | | L |
| over | up to and including | | up to and including | over | up to and including | over |
| 0,99 | 1,4 | 0,2 | 0,5 | 0,5 | 1,4 | 1,4 |
| | | 0,25 | 0,6 | 0,6 | 1,7 | 1,7 |
| | | 0,3 | 0,7 | 0,7 | 2 | 2 |
| 1,4 | 2,8 | 0,2 | 0,5 | 0,5 | 1,5 | 1,5 |
| | | 0,25 | 0,6 | 0,6 | 1,9 | 1,9 |
| | | 0,35 | 0,8 | 0,8 | 2,6 | 2,6 |
| | | 0,4 | 1 | 1 | 3 | 3 |
| | | 0,45 | 1,3 | 1,3 | 3,8 | 3,8 |
| 2,8 | 5,6 | 0,35 | 1 | 1 | 3 | 3 |
| | | 0,5 | 1,5 | 1,5 | 4,5 | 4,5 |
| | | 0,6 | 1,7 | 1,7 | 5 | 5 |
| | | 0,7 | 2 | 2 | 6 | 6 |
| | | 0,75 | 2,2 | 2,2 | 6,7 | 6,7 |
| | | 0,8 | 2,5 | 2,5 | 7,5 | 7,5 |
| 5,6 | 11,2 | 0,75 | 2,4 | 2,4 | 7,1 | 7,1 |
| | | 1 | 3 | 3 | 9 | 9 |
| | | 1,25 | 4 | 4 | 12 | 12 |
| | | 1,5 | 5 | 5 | 15 | 15 |
| 11,2 | 22,4 | 1 | 3,8 | 3,8 | 11 | 11 |
| | | 1,25 | 4,5 | 4,5 | 13 | 13 |
| | | 1,5 | 5,6 | 5,6 | 16 | 16 |
| | | 1,75 | 6 | 6 | 18 | 18 |
| | | 2 | 8 | 8 | 24 | 24 |
| | | 2,5 | 10 | 10 | 30 | 30 |
| 22,4 | 45 | 1 | 4 | 4 | 12 | 12 |
| | | 1,5 | 6,3 | 6,3 | 19 | 19 |
| | | 2 | 8,5 | 8,5 | 25 | 25 |
| | | 3 | 12 | 12 | 36 | 36 |
| | | 3,5 | 15 | 15 | 45 | 45 |
| | | 4 | 18 | 18 | 53 | 53 |
| | | 4,5 | 21 | 21 | 63 | 63 |
| 45 | 90 | 1,5 | 7,5 | 7,5 | 22 | 22 |
| | | 2 | 9,5 | 9,5 | 28 | 28 |
| | | 3 | 15 | 15 | 45 | 45 |
| | | 4 | 19 | 19 | 56 | 56 |
| | | 5 | 24 | 24 | 71 | 71 |
| | | 5,5 | 28 | 28 | 85 | 85 |
| | | 6 | 32 | 32 | 95 | 95 |
| 90 | 180 | 2 | 12 | 12 | 36 | 36 |
| | | 3 | 18 | 18 | 53 | 53 |
| | | 4 | 24 | 24 | 71 | 71 |
| | | 6 | 36 | 36 | 106 | 106 |
| | | 8 | 45 | 45 | 132 | 132 |
| 180 | 355 | 3 | 20 | 20 | 60 | 60 |
| | | 4 | 26 | 26 | 80 | 80 |
| | | 6 | 40 | 40 | 118 | 118 |
| | | 8 | 50 | 50 | 150 | 150 |

## 9 Crest diameter tolerances

### 9.1 Minor diameter tolerances of internal threads ($T_{D1}$)

For the minor diameter tolerance of internal thread ($T_{D1}$) there are five tolerance grades 4, 5, 6, 7 and 8, in accordance with Table 3.

### 9.2 Major diameter tolerance of external thread ($T_d$)

For the major diameter tolerance of external thread ($T_d$) there are three tolerance grades 4, 6 and 8, in accordance with Table 4.

The tolerance grades 5 and 7 do not exist for the major diameter of external threads.

**Table 3 — Minor diameter tolerance of internal thread ($T_{D1}$)**

| Pitch | Tolerance grades | | | | |
|---|---|---|---|---|---|
| $P$ | 4 | 5 | 6 | 7 | 8 |
| mm | µm | µm | µm | µm | µm |
| 0,2 | 38 | — | — | — | — |
| 0,25 | 45 | 56 | — | — | — |
| 0,3 | 53 | 67 | 85 | — | — |
| 0,35 | 63 | 80 | 100 | — | — |
| 0,4 | 71 | 90 | 112 | — | — |
| 0,45 | 80 | 100 | 125 | — | — |
| 0,5 | 90 | 112 | 140 | 180 | — |
| 0,6 | 100 | 125 | 160 | 200 | — |
| 0,7 | 112 | 140 | 180 | 224 | — |
| 0,75 | 118 | 150 | 190 | 236 | — |
| 0,8 | 125 | 160 | 200 | 250 | 315 |
| 1 | 150 | 190 | 236 | 300 | 375 |
| 1,25 | 170 | 212 | 265 | 335 | 425 |
| 1,5 | 190 | 236 | 300 | 375 | 475 |
| 1,75 | 212 | 265 | 335 | 425 | 530 |
| 2 | 236 | 300 | 375 | 475 | 600 |
| 2,5 | 280 | 355 | 450 | 560 | 710 |
| 3 | 315 | 400 | 500 | 630 | 800 |
| 3,5 | 355 | 450 | 560 | 710 | 900 |
| 4 | 375 | 475 | 600 | 750 | 950 |
| 4,5 | 425 | 530 | 670 | 850 | 1 060 |
| 5 | 450 | 560 | 710 | 900 | 1 120 |
| 5,5 | 475 | 600 | 750 | 950 | 1 180 |
| 6 | 500 | 630 | 800 | 1 000 | 1 250 |
| 8 | 630 | 800 | 1 000 | 1 250 | 1 600 |

**Table 4 — Major diameter tolerance of external thread ($T_d$)**

| Pitch | Tolerance grades | | |
|---|---|---|---|
| $P$ | 4 | 6 | 8 |
| mm | µm | µm | µm |
| 0,2 | 36 | 56 | — |
| 0,25 | 42 | 67 | — |
| 0,3 | 48 | 75 | — |
| 0,35 | 53 | 85 | — |
| 0,4 | 60 | 95 | — |
| 0,45 | 63 | 100 | — |
| 0,5 | 67 | 106 | — |
| 0,6 | 80 | 125 | — |
| 0,7 | 90 | 140 | — |
| 0,75 | 90 | 140 | — |
| 0,8 | 95 | 150 | 236 |
| 1 | 112 | 180 | 280 |
| 1,25 | 132 | 212 | 335 |
| 1,5 | 150 | 236 | 375 |
| 1,75 | 170 | 265 | 425 |
| 2 | 180 | 280 | 450 |
| 2,5 | 212 | 335 | 530 |
| 3 | 236 | 375 | 600 |
| 3,5 | 265 | 425 | 670 |
| 4 | 300 | 475 | 750 |
| 4,5 | 315 | 500 | 800 |
| 5 | 335 | 530 | 850 |
| 5,5 | 355 | 560 | 900 |
| 6 | 375 | 600 | 950 |
| 8 | 450 | 710 | 1 180 |

## 10 Pitch diameter tolerances

For the pitch diameter tolerance of internal thread ($T_{D2}$), there are five tolerance grades 4, 5, 6, 7 and 8, in accordance with Table 5.

For the pitch diameter tolerance of external thread ($T_{d2}$) there are seven tolerance grades 3, 4, 5, 6, 7, 8 and 9, in accordance with Table 6.

**Table 5 — Pitch diameter tolerance of internal thread ($T_{D2}$)**

| Basic major diameter $D$ | | Pitch $P$ | Tolerance grades | | | | |
|---|---|---|---|---|---|---|---|
| over | up to and including | | 4 | 5 | 6 | 7 | 8 |
| mm | mm | mm | µm | µm | µm | µm | µm |
| 0,99 | 1,4 | 0,2 | 40 | — | — | — | — |
| | | 0,25 | 45 | 56 | — | — | — |
| | | 0,3 | 48 | 60 | 75 | — | — |
| 1,4 | 2,8 | 0,2 | 42 | — | — | — | — |
| | | 0,25 | 48 | 60 | — | — | — |
| | | 0,35 | 53 | 67 | 85 | — | — |
| | | 0,4 | 56 | 71 | 90 | — | — |
| | | 0,45 | 60 | 75 | 95 | — | — |
| 2,8 | 5,6 | 0,35 | 56 | 71 | 90 | — | — |
| | | 0,5 | 63 | 80 | 100 | 125 | — |
| | | 0,6 | 71 | 90 | 112 | 140 | — |
| | | 0,7 | 75 | 95 | 118 | 150 | — |
| | | 0,75 | 75 | 95 | 118 | 150 | — |
| | | 0,8 | 80 | 100 | 125 | 160 | 200 |
| 5,6 | 11,2 | 0,75 | 85 | 106 | 132 | 170 | — |
| | | 1 | 95 | 118 | 150 | 190 | 236 |
| | | 1,25 | 100 | 125 | 160 | 200 | 250 |
| | | 1,5 | 112 | 140 | 180 | 224 | 280 |
| 11,2 | 22,4 | 1 | 100 | 125 | 160 | 200 | 250 |
| | | 1,25 | 112 | 140 | 180 | 224 | 280 |
| | | 1,5 | 118 | 150 | 190 | 236 | 300 |
| | | 1,75 | 125 | 160 | 200 | 250 | 315 |
| | | 2 | 132 | 170 | 212 | 265 | 335 |
| | | 2,5 | 140 | 180 | 224 | 280 | 355 |
| 22,4 | 45 | 1 | 106 | 132 | 170 | 212 | — |
| | | 1,5 | 125 | 160 | 200 | 250 | 315 |
| | | 2 | 140 | 180 | 224 | 280 | 355 |
| | | 3 | 170 | 212 | 265 | 335 | 425 |
| | | 3,5 | 180 | 224 | 280 | 355 | 450 |
| | | 4 | 190 | 236 | 300 | 375 | 475 |
| | | 4,5 | 200 | 250 | 315 | 400 | 500 |
| 45 | 90 | 1,5 | 132 | 170 | 212 | 265 | 335 |
| | | 2 | 150 | 190 | 236 | 300 | 375 |
| | | 3 | 180 | 224 | 280 | 355 | 450 |
| | | 4 | 200 | 250 | 315 | 400 | 500 |
| | | 5 | 212 | 265 | 335 | 425 | 530 |
| | | 5,5 | 224 | 280 | 355 | 450 | 560 |
| | | 6 | 236 | 300 | 375 | 475 | 600 |
| 90 | 180 | 2 | 160 | 200 | 250 | 315 | 400 |
| | | 3 | 190 | 236 | 300 | 375 | 475 |
| | | 4 | 212 | 265 | 335 | 425 | 530 |
| | | 6 | 250 | 315 | 400 | 500 | 630 |
| | | 8 | 280 | 355 | 450 | 560 | 710 |
| 180 | 355 | 3 | 212 | 265 | 335 | 425 | 530 |
| | | 4 | 236 | 300 | 375 | 475 | 600 |
| | | 6 | 265 | 335 | 425 | 530 | 670 |
| | | 8 | 300 | 375 | 475 | 600 | 750 |

**Table 6 — Pitch diameter tolerance of external thread ($T_{d2}$)**

| Basic major diameter $d$ | | Pitch $P$ | Tolerance grades | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| over | up to and including | | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| mm | mm | mm | µm | µm | µm | µm | µm | µm | µm |
| 0,99 | 1,4 | 0,2 | 24 | 30 | 38 | 48 | — | — | — |
| | | 0,25 | 26 | 34 | 42 | 53 | — | — | — |
| | | 0,3 | 28 | 36 | 45 | 56 | — | — | — |
| 1,4 | 2,8 | 0,2 | 25 | 32 | 40 | 50 | — | — | — |
| | | 0,25 | 28 | 36 | 45 | 56 | — | — | — |
| | | 0,35 | 32 | 40 | 50 | 63 | 80 | — | — |
| | | 0,4 | 34 | 42 | 53 | 67 | 85 | — | — |
| | | 0,45 | 36 | 45 | 56 | 71 | 90 | — | — |
| 2,8 | 5,6 | 0,35 | 34 | 42 | 53 | 67 | 85 | — | — |
| | | 0,5 | 38 | 48 | 60 | 75 | 95 | — | — |
| | | 0,6 | 42 | 53 | 67 | 85 | 106 | — | — |
| | | 0,7 | 45 | 56 | 71 | 90 | 112 | — | — |
| | | 0,75 | 45 | 56 | 71 | 90 | 112 | — | — |
| | | 0,8 | 48 | 60 | 75 | 95 | 118 | 150 | 190 |
| 5,6 | 11,2 | 0,75 | 50 | 63 | 80 | 100 | 125 | — | — |
| | | 1 | 56 | 71 | 90 | 112 | 140 | 180 | 224 |
| | | 1,25 | 60 | 75 | 95 | 118 | 150 | 190 | 236 |
| | | 1,5 | 67 | 85 | 106 | 132 | 170 | 212 | 265 |
| 11,2 | 22,4 | 1 | 60 | 75 | 95 | 118 | 150 | 190 | 236 |
| | | 1,25 | 67 | 85 | 106 | 132 | 170 | 212 | 265 |
| | | 1,5 | 71 | 90 | 112 | 140 | 180 | 224 | 280 |
| | | 1,75 | 75 | 95 | 118 | 150 | 190 | 236 | 300 |
| | | 2 | 80 | 100 | 125 | 160 | 200 | 250 | 315 |
| | | 2,5 | 85 | 106 | 132 | 170 | 212 | 265 | 335 |
| 22,4 | 45 | 1 | 63 | 80 | 100 | 125 | 160 | 200 | 250 |
| | | 1,5 | 75 | 95 | 118 | 150 | 190 | 236 | 300 |
| | | 2 | 85 | 106 | 132 | 170 | 212 | 265 | 335 |
| | | 3 | 100 | 125 | 160 | 200 | 250 | 315 | 400 |
| | | 3,5 | 106 | 132 | 170 | 212 | 265 | 335 | 425 |
| | | 4 | 112 | 140 | 180 | 224 | 280 | 355 | 450 |
| | | 4,5 | 118 | 150 | 190 | 236 | 300 | 375 | 475 |
| 45 | 90 | 1,5 | 80 | 100 | 125 | 160 | 200 | 250 | 315 |
| | | 2 | 90 | 112 | 140 | 180 | 224 | 280 | 355 |
| | | 3 | 106 | 132 | 170 | 212 | 265 | 335 | 425 |
| | | 4 | 118 | 150 | 190 | 236 | 300 | 375 | 475 |
| | | 5 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| | | 5,5 | 132 | 170 | 212 | 265 | 335 | 425 | 530 |
| | | 6 | 140 | 180 | 224 | 280 | 355 | 450 | 560 |
| 90 | 180 | 2 | 95 | 118 | 150 | 190 | 236 | 300 | 375 |
| | | 3 | 112 | 140 | 180 | 224 | 280 | 355 | 450 |
| | | 4 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| | | 6 | 150 | 190 | 236 | 300 | 375 | 475 | 600 |
| | | 8 | 170 | 212 | 265 | 335 | 425 | 530 | 670 |
| 180 | 355 | 3 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| | | 4 | 140 | 180 | 224 | 280 | 355 | 450 | 560 |
| | | 6 | 160 | 200 | 250 | 315 | 400 | 500 | 630 |
| | | 8 | 180 | 224 | 280 | 355 | 450 | 560 | 710 |

## 11 Root contours

For internal threads as well as for external threads, the actual root contours shall not at any point transgress the basic profile.

For external threads on fasteners of property class 8.8 and higher (see ISO 898-1), the root profile shall have a non-reversing curvature, no portion of which shall have a radius of less than $0{,}125 \times P$ (see Table 7).

In the maximum minor diameter position, $d_3$, the two radii $R_{min} = 0{,}125\ P$ will go through the points of intersection between the maximum material flanks and the minor diameter cylinder of the Go-gauges according to ISO 1502 and blend tangentially into the minimum material flanks.

The maximum truncation, $C_{max}$, is calculated according to the following formula:

$$C_{max} = \frac{H}{4} - R_{min}\left\{1 - \cos\left[\frac{\pi}{3} - \arccos\left(1 - \frac{T_{d2}}{4 \cdot R_{min}}\right)\right]\right\} + \frac{T_{d2}}{2}$$

It is, however, advisable to aspire to a truncation of $\frac{H}{6}$ ($R = 0{,}144\ 34 \times P$) and to take $\frac{H}{6}$ as the basis for stress calculation of the minor diameter, $d_3$, of external threads (for corresponding values see ISO 965-3).

The minimum truncation, $C_{min}$, is calculated according to the following formula:

$$C_{min} = 0{,}125\ P \approx \frac{H}{7}$$

External threads on fasteners of property classes below 8.8 should preferably conform to the requirements stated above. This is particularly important for fasteners or other screwed connections which are subjected to fatigue or impact. However, there are in principle no restrictions other than that the maximum minor diameter, $d_{3\,max}$, of the external thread shall be less than the minimum minor diameter of the Go-gauges according to ISO 1502.

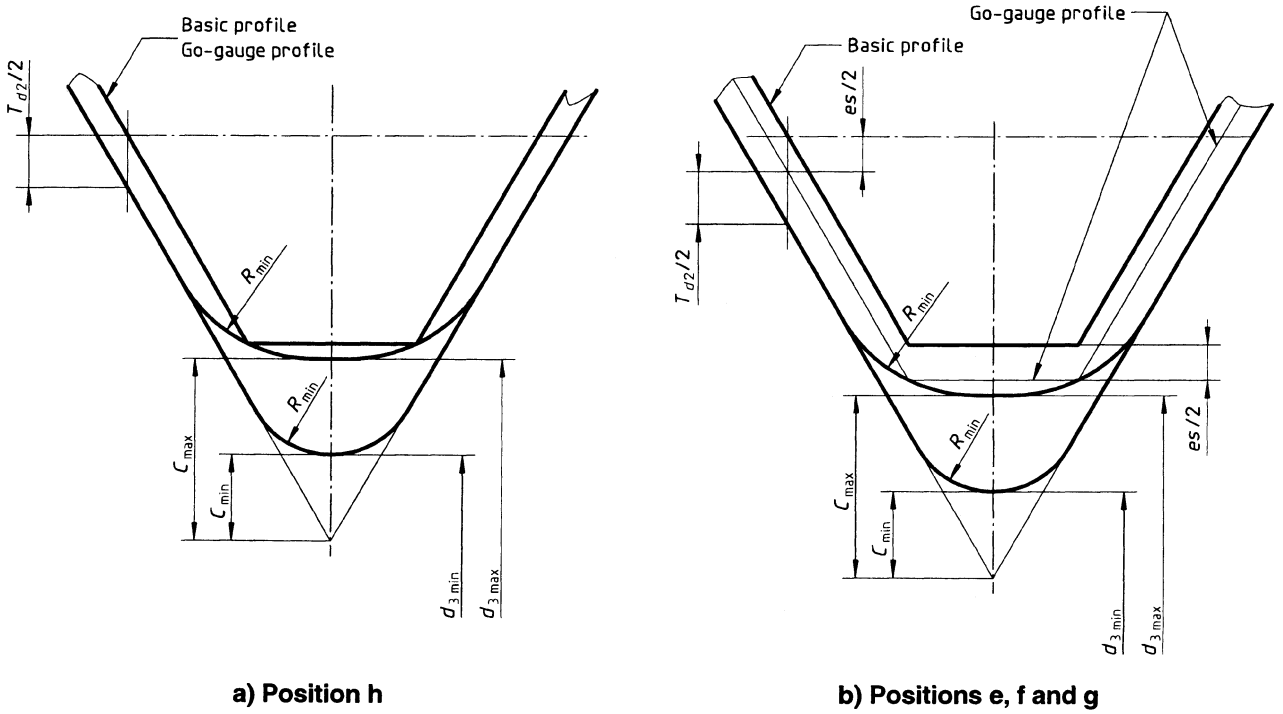



**Figure 6 — External root profile**

**Table 7 — Minimum root radii**

| **Pitch** $P$ mm | $R_{min}$ µm |
|---|---|
| 0,2 | 25 |
| 0,25 | 31 |
| 0,3 | 38 |
| 0,35 | 44 |
| 0,4 | 50 |
| 0,45 | 56 |
| 0,5 | 63 |
| 0,6 | 75 |
| 0,7 | 88 |
| 0,75 | 94 |
| 0,8 | 100 |
| 1 | 125 |
| 1,25 | 156 |
| 1,5 | 188 |
| 1,75 | 219 |
| 2 | 250 |
| 2,5 | 313 |
| 3 | 375 |
| 3,5 | 438 |
| 4 | 500 |
| 4,5 | 563 |
| 5 | 625 |
| 5,5 | 688 |
| 6 | 750 |
| 8 | 1 000 |

## 12 Recommended tolerance classes

In order to reduce the number of gauges and tools, the tolerance classes should preferably be chosen from Table 8 and Table 9.

The following general rules can be formulated for the choice of tolerance quality:

— fine: for precisions threads, when little variation of fit character is needed.

— medium: for general use.

— coarse: for cases where manufacturing difficulties can arise, for example when threading hot-rolled bars and long blind holes.

If the actual length of thread engagement is unknown (as in the manufacturing of standard bolts), group N is recommended.

Tolerance classes within broad frames are selected for commercial external and internal threads.

Tolerance classes in bold print are first choice.

Tolerance classes in ordinary print are second choice.

Tolerance classes in parentheses are third choice.

Any of the recommended tolerance classes for internal threads can be combined with any of the recommended tolerance classes for external threads. However, in order to guarantee sufficient overlap, the finished components should preferably be made to form the fits H/g, H/h or G/h. For thread sizes M1,4 and smaller the combinations 5H/6h, 4H/6h or finer shall be chosen.

For coated threads, the tolerances apply to the parts before coating, unless otherwise stated. After coating, the actual thread profile shall not at any point transgress the maximum material limits for positions H or h.

NOTE These provisions are intended for thin coatings, e.g. those obtained by electroplating.

**Table 8 — Recommended tolerance classes for internal threads**

| Tolerance quality | Tolerance position G | | | Tolerance position H | | |
|---|---|---|---|---|---|---|
| | S | N | L | S | N | L |
| fine | — | — | — | 4H | 5H | 6H |
| medium | (5G) | **6G** | (7G) | **5H** | **6H** | **7H** |
| coarse | — | (7G) | (8G) | — | 7H | 8H |

**Table 9 — Recommended tolerance classes for external threads**

| Tolerance quality | Tolerance position e | | | Tolerance position f | | | Tolerance position g | | | Tolerance position h | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S | N | L | S | N | L | S | N | L | S | N | L |
| fine | — | — | — | — | — | — | — | (4g) | (5g4g) | (3h4h) | **4h** | (5h4h) |
| medium | — | **6e** | (7e6e) | — | **6f** | — | (5g6g) | **6g** | (7g6g) | (5h6h) | 6h | (7h6h) |
| coarse | — | (8e) | (9e8e) | — | — | — | — | 8g | (9g8g) | — | — | — |

## 13 Formulae

The values given in this part of ISO 965 are based on experience. In order to obtain a consistent system, mathematical formulae have been developed.

The values for pitch and crest diameter tolerances and for fundamental deviations have been calculated from the formulae and then rounded off to the nearest value in the R 40 series of preferred numbers. However, when decimals appear, the value has been further rounded off to the nearest whole number.

In order to reproduce a smooth progression, these rules of rounding off have not always been used.

The root radii specified in Table 7 are equal to 0,125 $P$.

### 13.1 Fundamental deviations

The fundamental deviations for internal and external threads have been calculated according to the following formulae:

$EI_G = + (15 + 11\,P)$

$EI_H = 0$

$es_e = - (50 + 11\,P)$[2)]

$es_f = - (30 + 11\,P)$[3)]

$es_g = - (15 + 11\,P)$

$es_h = 0$

where $EI$ and $es$ are expressed in micrometers and $P$ is expressed in millimetres.

### 13.2 Length of thread engagement

For the calculation of the limits of the normal length of thread engagement $l_N$ in Table 2, the following rule has been applied.

For each pitch within a certain diameter range, $d$ has been set equal to the smallest diameter (within the range) which appears in the general plan (see ISO 261).

$l_{N\,min}$ (approximate) = $2{,}24\,P\,d^{0,2}$

$l_{N\,max}$ (approximate) = $6{,}7\,P\,d^{0,2}$

where $l_N$, $P$ and $d$ are expressed in millimetres.

[2)] Exceptions are values for threads with $P \leqslant 0{,}45$ millimetres

[3)] Does not apply for $P \leqslant 0{,}3$ millimetres

### 13.3 Crest diameter tolerances

#### 13.3.1 *Tolerances for major diameter of external thread* ($T_d$)*, grade 6*

These tolerances have been calculated according to the following formula:

$$T_d(6) = 180\sqrt[3]{P^2} - \frac{3{,}15}{\sqrt{P}}$$

where $T_d$ is expressed in micrometers and $P$ is expressed in millimetres.

$T_d$-tolerances for the other grades are obtained from the $T_d(6)$-values (see Table 4) according to the table below.

| Tolerance grade | | |
|---|---|---|
| 4 | 6 | 8 |
| 0,63 $T_d(6)$ | $T_d(6)$ | 1,6 $T_d(6)$ |

#### 13.3.2 *Tolerances for minor diameter of internal thread* ($T_{D1}$)*, grade 6*

$T_{D1}$-Tolerances for grade 6 are calculated according to the following formulae:

a) Pitches 0,2 mm to 0,8 mm

$T_{D1}(6) = 433P - 190P^{1,22}$

b) Pitch 1 mm and coarser

$T_{D1}(6) = 230P^{0,7}$

where $T_{D1}$ is expressed in µm and $P$ is expressed in mm.

The value for other grades are obtained from the $T_{D1}(6)$-values (in Table 3) according to the table below.

| Tolerance grade | | | | |
|---|---|---|---|---|
| 4 | 5 | 6 | 7 | 8 |
| 0,63 $T_{D1}(6)$ | 0,8 $T_{D1}(6)$ | $T_{D1}(6)$ | 1,25 $T_{D1}(6)$ | 1,6 $T_{D1}(6)$ |

### 13.4 Pitch diameter tolerances

#### 13.4.1 *Tolerances for pitch diameter of external thread* ($T_{d2}$)

$T_{d2}(6)$-values in Table 6 are calculated according to the following formulae ($d$ being equal to the geometrical mean value of the diameter range limits):

$T_{d2}(6) = 90\ P^{0,4}d^{0,1}$

where

$T_{d2}(6)$ is expressed in micrometers and $P$ and $d$ are expressed in millimetres.

The value for the other grades are obtained from the $T_{d2}(6)$-values (see Table 6) according to the table below.

| Tolerance grades | | | | | | |
|---|---|---|---|---|---|---|
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 0,5 $T_{d2}(6)$ | 0,63 $T_{d2}(6)$ | 0,8 $T_{d2}(6)$ | $T_{d2}(6)$ | 1,25 $T_{d2}(6)$ | 1,6 $T_{d2}(6)$ | 2 $T_{d2}(6)$ |

No $T_{d2}$-values are given in Table 6 when values calculated according to the given formulae exceed the $T_d$-values in the tolerance grades which are combined in the tables for recommended tolerance classes.

#### 13.4.2 *Tolerances for pitch diameter of internal thread* ($T_{D2}$)

$T_{D2}$-values are obtained from the $T_{d2}(6)$-values (see Table 6) according to the table below.

| Tolerance grade | | | | |
|---|---|---|---|---|
| 4 | 5 | 6 | 7 | 8 |
| 0,85 $T_{d2}(6)$ | 1,06 $T_{d2}(6)$ | 1,32 $T_{d2}(6)$ | 1,7 $T_{d2}(6)$ | 2,12 $T_{d2}(6)$ |

No $T_{D2}$-values are given in Table 5 when values calculated according to the given formulae exceed 0,25 $P$.

## [AC1] Bibliography

[1] ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread* [AC1]

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